HOME OFFICE.

REPORT ON AN

EXPLOSION

which occurred on 5th May, 1930, at the works of MESSRS. J. BIBBY & SONS, LTD., Liverpool.

BY

H. J. PEACOCK

(H.M. Deputy Superintending Inspector of Factories)

AND

L. C. McNAIR

(H.M. Engineering Inspector of Factories).

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EXPLOSION ON 5th MAY, 1930, AT THE OIL-CAKE WORKS OF MESSRS. J. BIBBY & SONS, LTD., LIVERPOOL.

To H.M. Chief Inspector of Factories,

Sir,

We beg to report that, in accordance with instructions, we have investigated the explosion which occurred on Monday, 5th May, 1930, at the works of Messrs. J Bibby & Sons, Ltd., Liverpool. We visited the works on the day following the explosion, and further visits were paid by us during the following eight days.

The explosion took place on the top floor of the silo building. Eleven men died from their injuries; 32 others suffered injury by burning.

This accident happened in a plant used only for storage, and though there was, no doubt, a dust explosion, the conditions were entirely different from those obtaining in any previous explosion known to us which has occurred in this country. An explosion which occurred in 1911 in a separate part of this factory took place in a grinding plant, under conditions entirely dissimilar to the present case (*see* Cd. 6223, 1912).

The silo building consists of eleven storeys and contains 22 steel silos, one sub-divided into 32 smaller "pocket" silos, each 95 ft. deep and varying in section, some measuring 22 ft. by 11 ft. and others 11 ft. by 9 ft. in cross section. The large silos have a capacity of 300 tons. Each silo forms a unit in what is practically a long rectangular steel box (95 ft. deep) sub-divided by vertical partition steel plates so that there is only the thickness of these plates between contiguous silos. They are supported on vertical steel columns which rise to the level of the seventh floor.

Where four silos adjoin one another, the top of the central supporting column passes through the right-angled corner common to the four and is blanked off from each silo by a corner plate through which pass the horizontal floor girders. The tops of the silos are level with the gangways on the top floor and 12 ft. above this there is a concrete roof.

The north and south ends of this top floor were closed by corrugated iron plates (blown out by the explosion) and on the east side wall there are a number of elevators which bring material from the ground level and discharge it on to cross conveyor bands running east to west. These in turn discharge to conveyor worms running along the tops of the silos, north and south. From the conveyor worms the material drops into the silos as required through long inclined chutes. These feed chutes are specially designed to prevent formation of dust clouds in the silos when filling is in progress.

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At the bottom of each silo there is a valve feeding a revolving table which, when in action, causes the stored material passing out of the silo to fall into a chute leading to conveyor worms below the floor. During the filling of a silo there is a tendency for the material to pack unevenly and to prevent this ⩘ shaped cross distributing beams are fixed in each silo. They are spaced 2 ft. 11 in. apart and one row is 3 ft. below the row above in a hit and miss arrangement. The silos were designed to carry only the relatively light materials stored in them.

A plan of the arrangement of the four silos concerned in the explosion is shown in Fig. 1. They were numbered 2, 3, 11 and 13, and were filled as follows:—

No. 2.—Rangoon rice bran.
,, 3.—Parboiled rice bran.
,, 11.—Sunflower seed cake.
,, 13.—Soya bean meal.

So far as can be ascertained, it has not been customary in this country to use silos for storing such materials. We were informed that one of the reasons for doing so was because it was thought that there would be less danger of spontaneous combustion if the materials were stored in this way rather than in bags.

Sunflower seed has been found to be particularly prone to "fire" when stored in bags, owing to the amount of readily oxidisable oil contained in it.

CIRCUMSTANCES OF THE EXPLOSION.

On Friday night (2nd May, 1930), No. 11 silo showed signs of spontaneous combustion, smoke in very slight quantities issuing from the corner A. Steps were taken to empty the silo, and the firm's fire brigade played water on the top of the material in this silo until the emptying was completed on Saturday night. At no time, according to the evidence, was there more smoke at the top of the silo than might be caused by a man smoking his pipe. On Saturday night (3rd May), it was noticed that smoke was coming from No. 13, at corner B, and this silo was emptied by Sunday night. A little later, on Saturday night, No. 2 began to smoke at corner C and they began to empty it in a similar manner, the process being finished on Sunday night (4th May). On Sunday night, No. 3 began to smoke in corner D and they started to empty that also. On the Monday morning (5th May), at nine o'clock, No. 2 was empty and No. 3 smoking very little; the firm's fire brigade were concentrating their attention on it, while at the same time the material was being removed in the usual fashion at the bottom valve. On the same morning, the engineers (Mr. Evans and Mr. Hiorns) descended into No. 11 silo and found that the plates were a little

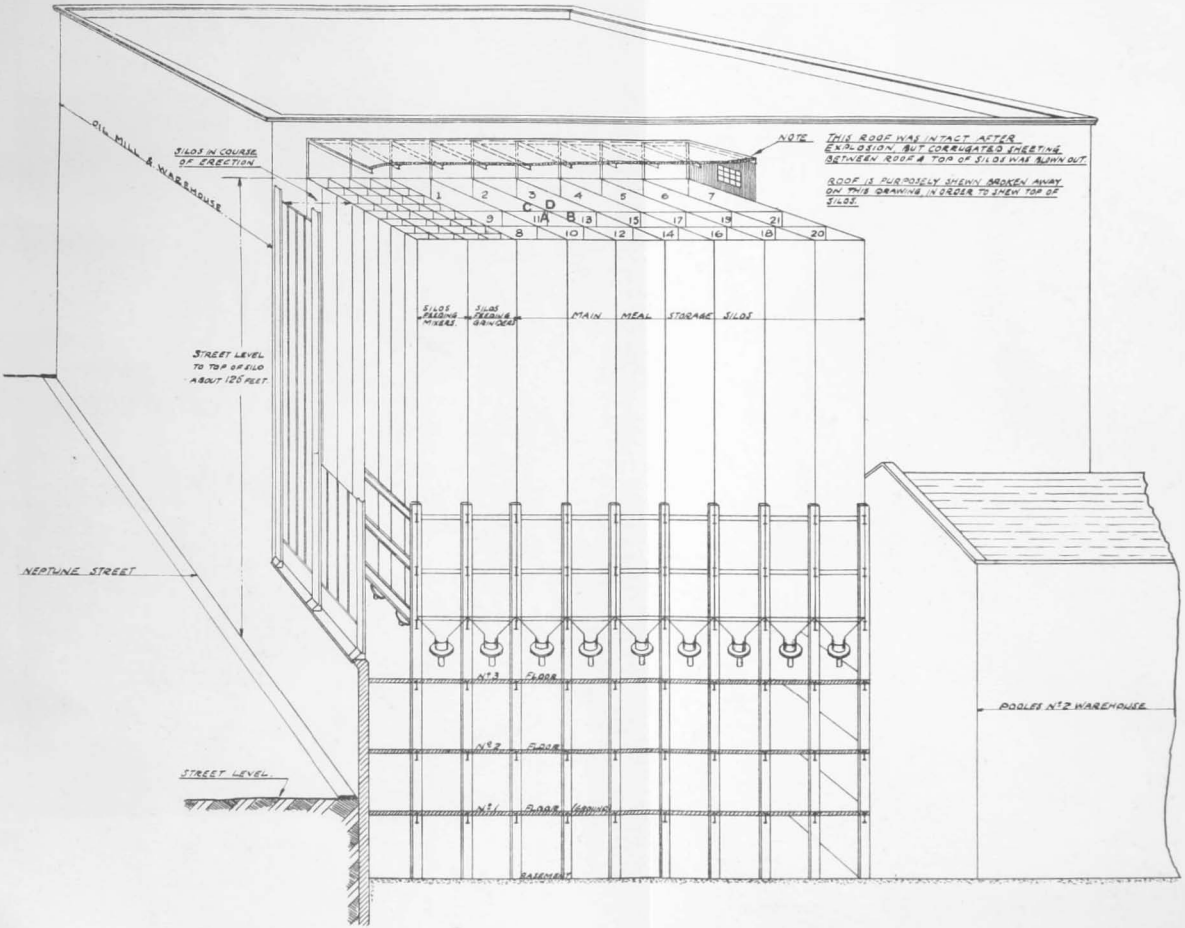

FIG. I. GENERAL VIEW OF SILO HOUSE.

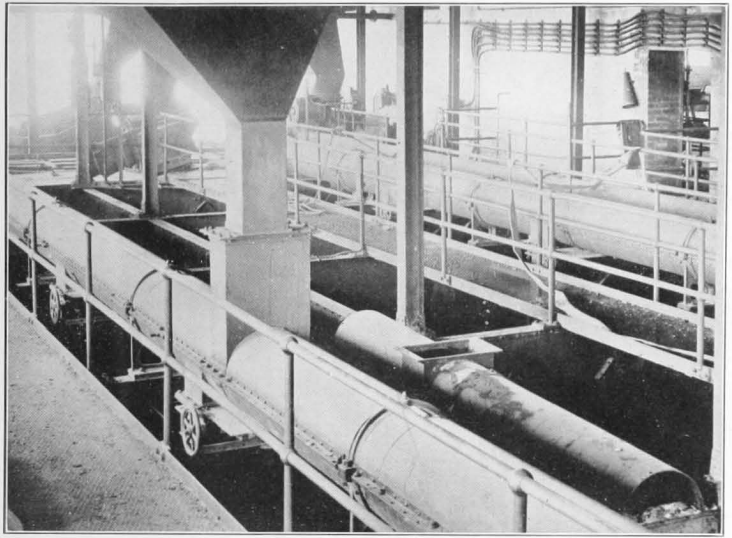

FIG. 2.—View taken on top floor of silo house shewing the tops of the silos, the conveyor worm tubes feeding them, and working gangways. View from South West end.

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[To face page 5.

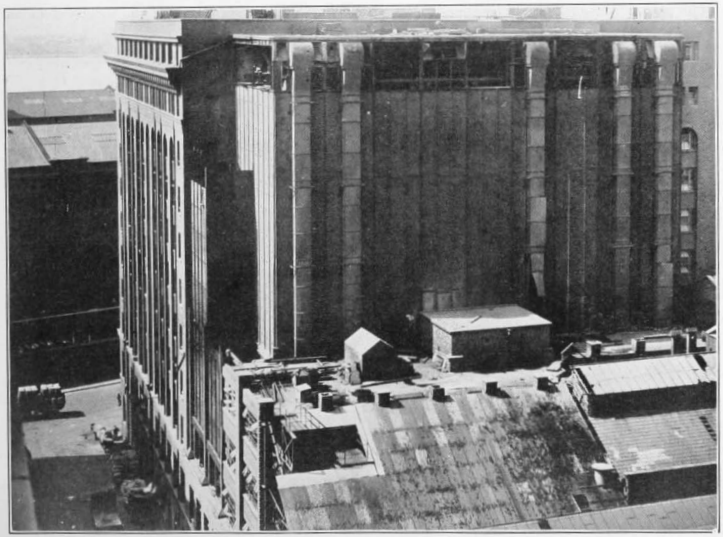

FIG. 3.—Outside view of main warehouse and silo house from south east, shewing gaps where galvanised sheeting was blown out, also damage at the lower ends of the elevators.

scorched and one plate was slightly buckled by the heat. It was shortly after this, at a time when only 40 tons of material remained in No. 3 silo, that the explosion took place.

The evidence of the firemen is to the effect that during the period from Friday night to Monday morning, although there was little emission of smoke from the top of the silos, there was from time to time evidence of fire at the top of the column at the centre of the four silos. Hoses were put up and, finally, wet bags were pushed up the confined space so as to exclude air as far as possible. From the evidence, the fire appears to have been put out completely by daybreak on Monday, but there was a further outbreak at 9.30 that morning. It is evident that the fire at this point was due to air getting into the silo through the very small gaps between the floor girders and the corner plates referred to above.

McClure, the charge hand on No. 3 floor, states that on Monday morning he was running off the contents of No. 3 silo which appeared to be cool and perfectly normal. At 11.20 he heard a heavy fall of meal inside No. 3 and immediately afterwards a loud report, and a flash came down the elevator. According to this witness, there was a second report one or two minutes later.

Mr. James Bibby, Mr. Hiorns and the charge hand Perry were, at the time of the explosion, in No. 13 silo. They came out of the silo, and were passing along the top floor when they were caught by the second explosion and blown in the direction from north to south.

RESULT OF THE EXPLOSION.

It is, we consider, evident that the explosive wave issuing from the silo was deflected by the concrete roof and then travelled in two directions (north and south) along the top floor and blew out the end corrugated panels, part of the wave passing down the elevator casings on the east wall and damaging them at their lowest points. No damage was done by the explosion to the silos themselves nor to the conveyor worm tubes directly above them. The overhead roof was slightly cracked in places, but the most serious damage was that which occurred at the bottom of the elevators. Some of the corrugated sheets which covered the north and south ends of the room were blown out, one of them being projected a distance of about 100 ft.

CAUSE OF THE EXPLOSION.

The heating of the sunflower seed cake and consequent transference of heat through the thin steel walls to the adjoining silos was, we consider, the original cause of the explosion. The fire which occurred from time to time in the centre space at the top of the column between the four silos was no doubt rendered possible by admission of air in small amount through slight gaps in the corner plates at the points where the floor girders pass through.

In our opinion the actual explosion may have been due to one of two causes.

(1) It may be that when silo No. 3 was being slowly emptied, some of the material formed a bridge on the cross spreader beams, and, later on, when the material below which was burning had dropped some considerable distance, the bridge of material collapsed and, in falling, produced a dust cloud which was ignited by the fire below. The dust of parboiled rice bran is explosive. *

The evidence of the witness McClure (charge hand on No. 3 floor) supports this theory.

2. Another possible explanation is that when the material began to burn in a limited amount of air, some carbon monoxide was evolved ; part of this would probably be burnt, but some may have escaped unburnt into the mass of material inside the silo. The falling of the material in the silo may have eventually caused the gas to be diluted with air and, when this mixture was ignited, the resultant small explosion raised a dust cloud which was in turn ignited with a more violent secondary explosion.

We think that the amount of inflammable gas, if formed as suggested above, could not have been very great, because before such a mixture could explode, it would have to contain (in the case of carbon monoxide) at least 12 per cent. of that gas. If such a mixture had been present in quantity in the silo there must, we consider, have been evidence of " gassing " among the men working on the top floor. Further, No. 3 silo had been entered several times on the Monday morning by the charge hand Perry without any evidence of poisonous gas being present.

The second explosion was possibly due to dust being blown up from some of the other silos by the first explosive wave.

CORONER'S INQUIRY.

The inquest was held on 14th May, 1930, at the Coroner's Court, Dale Street, Liverpool, by the Coroner, G. E. Mort, Esq., who conducted a most searching and painstaking inquiry into the whole of the circumstances attending the accident. The finding of the jury was " that the deceased died from shock due to burns caused by explosions following spontaneous combustions of sunflower meal and rice meal in silos at Messrs. Bibby's Oil Cake Mills in Neptune Street on the 5th instant."

The jury further recommended that " before any alterations to the silos are proceeded with the proposals should be submitted

* Its explosive qualities have since been confirmed by the Mines Department Testing Station after examination of samples from the silo. The samples were submitted to the tests outlined in the Report on the Inflammability and Capacity for transmitting Explosions of Carbonaceous Dusts liable to be generated on Premises under the Factory and Workshop Acts, by R. V. Wheeler, D.Sc. (Cd. 6662, 1913) and placed in Class I.

to the Home Office for approval." Mr. Dodds, on behalf of the firm, promised that this recommendation would be acted upon and said :—

"Messrs. Bibby are exceedingly grateful to His Majesty's Inspectors for the care and attention which they have bestowed upon this very difficult subject, and for valuable suggestions they have made. They wish me to assure you that all these suggestions will be fully and carefully considered with a view to avoiding like accidents in the future and minimising the risk to human life. They welcome the co-operation of the Home Office, and they will be very glad to give all facilities for experiments and for further inquiry from every quarter."

METHODS OF PREVENTION.

Several methods for preventing such accidents have been suggested by us and the firm have agreed to experiment in these directions. They are as follows :—

(1) It seems desirable that in erecting such plant in future, the silos should be separated from each other either by adequate air spacing or by the use of heat-insulating material. Steps should also be taken to ensure that there are no gaps between plates, girders, etc., through which air can gain admission at the sides.

(2) The concrete roof above the top floor no doubt deflected the flames along the floors and gangways where the men were at work. We suggest that the silos should be continued through this roof and that the tops should be covered by light covers which will lift in case of an explosion and allow the flame to pass to open air without danger to men working on the floor below.

(3) It may, we suggest, be possible to deal with any fire in a silo by installing tubes fitted with fusible plugs connected to a carbon-dioxide or other inert gas pressure supply, so that in case of any rise in temperature an escape of gas sufficient to extinguish the fire in the zone affected will take place. It will, at the same time, be necessary to provide an alarm to give warning when this device comes into action. Provision will have to be made to ensure that the bottom valves are gas-tight and for testing carefully by automatic apparatus or other means, so as to prevent any risk of "gassing" of persons below the silos or of persons entering the silos afterwards.

(4) The provision of recording thermometers on the silos should, we think, be considered.

In addition, Messrs. Bibby are, we understand, considering the desirability of shortening the silos, as it is thought that the depth may have tended to increase the risk of spontaneous ignition.

It is obvious that the above suggestions will require very careful experiment and consideration before they are put into practice.

We desire to express our appreciation to Messrs. Bibby & Sons, and their staff, for their courtesy in giving us every facility for obtaining evidence,

We are,

Sir,

Your obedient Servants,

HENRY J. PEACOCK,

H.M. Deputy Superintending Inspector of Factories, Liverpool.

L. C. McNAIR,

H.M. Engineering Inspector of Factories, Home Office.

29th May, 1930.

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